Entangled-Guided Photon Generation in 1+1 D photonic crystals

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It is well known that photonic crystals (PhC) can support confined electromagnetic propagation. We consider a 1-D photonic crystal as a multi-channel waveguide for generating counterpropagating twin photons by spontaneous paramentric down-convertion. Considering $k_{\omega p}$ the wave-vector of the pump field at frequency ω_p tuned at the band-edge of the transmission spectrum for a normal incidence, $\beta_{\omega(s,p)}$ and $\beta_{\omega(i,s)}$ the wave-vector z-component of the generated-guided modes at the signal frequency (ω_s) and idler frequency (ω_i) respectively p and s polarized, if the non linear layer thickness is small enough there is no mis-match in x direction so the momentum conservation needs to be fulfilled only along the z direction. Due to the modal dispersion of the structure, the momentum conservation can be fulfilled for different frequencies with different polarizations that is $\beta_{\omega(s,p)} = \beta_{\omega(i,s)}$. Because of the symmetry of our structure we can write the photon pair emitted along the z-axis as a entangled state, more precisely: $\left|\psi\right\rangle = \frac{1}{\sqrt{2}}\left(\left|p,up;s,down\right\rangle + \left|p,down;s,up\right\rangle\right)$. Note that the counterpropagating down-converted twin photons are entangled in frequency, momentum and polarization.